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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

Tsutomi HASHIZUME, et al.

Appln. No.: 08/835,748

Group Art Unit: 2853

Filed: April 10, 1997

Examiner: C. Dickens

For: INK JET RECORDING HEAD

SUBMISSION OF APPELLANTS' BRIEF ON APPEAL

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Submitted herewith please find an original and two copies of Appellants' Brief on Appeal. A check for the statutory fee of $300.00 is attached. Authorization is also given to charge or credit any difference or overpayment to Deposit Account No. 19-4880. A duplicate copy of this paper is attached.

Respectfully submitted,

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Date: November 29, 1999

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19/Appeal Brief
G. Stanley
12-15-99

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This is an Appeal from the Final Rejection of June 8, 1999 (Paper No. 14) of Claims 1-12.

Three copies of this Brief are enclosed.

STATUS OF CLAIMS

Claims 1-12, all the claims pending in the application, stand finally rejected.

STATUS OF AMENDMENTS

Appellants' Response under 35 U.S.C. §1.116 filed on September 2, 1999 (after the June 8, 1999 final Office Action) was considered by the Examiner. No amendments were made after the final Office Action.

SUMMARY OF THE INVENTION

The present invention is in the field of ink jet recording apparatuses, particularly ink jet recording heads having piezoelectric layers formed on a surface of an elastic sheet. The elastic sheet is part of a wall structure of pressure generating chambers. These pressure generating chambers communicate with nozzle orifices from which ink drops are allowed to issue by displacement of the piezoelectric layers.

By way of overview, the operating principle of ink-jet recording heads is such that the elastic sheet described above is displaced by means of piezoelectric vibrators (usually made of a piezoelectric layer sandwiched between upper and lower electrodes) to apply pressure to the ink in pressure generating chambers, thereby ejecting ink drops from nozzle orifices. Practically, ink-jet recording heads are one of a first type, that uses a vibrator of a longitudinally vibrating mode which extends and contracts along its own axis, and a second type, that uses a vibrator of a flexing of flexural vibrating mode. While the first type of conventional ink-jet recording heads is suitable for high density printing, it requires a complicated manufacturing process. On the other hand, in the second type of conventional ink-jet recording heads, the piezoelectric layer must be made very thin in order to permit fast driving of the piezoelectric element. In the second type of conventional ink-jet recording heads, reduced thickness results in reduced rigidity of the piezoelectric layer, thereby shortening the life of the ink-jet recording head. In addition, since the piezoelectric vibrator is driven at high voltage, both the upper and lower electrodes will experience surface discharge along the lateral sides of the piezoelectric layer which increases the chance of a leakage current flowing between the two electrodes, thereby destabilizing the

issuance of ink droplets. Furthermore, in the second type of conventional ink-jet recording devices, since the piezoelectric vibrator is segmented (in correspondence with individual pressure generating chambers), the areas of lateral sides that are exposed to air atmosphere are increased so that individual piezoelectric vibrators are prone to deteriorate due to the moisture in the air atmosphere. (See Appellants' specification at pages 1-3.)

Appellants' invention solves the above-noted problems of conventional ink-jet recording devices by providing an ink-jet recording head in which the stress concentration near the boundaries of each pressure generating chamber is reduced to prevent breakage of the upper electrode, and the occurrence of a leakage current throughout the piezoelectric layer held between the upper and the lower electrodes is prevented to stabilize the issuance of the ink droplets. Accordingly, in the ink-jet recording head according to the present invention the deterioration of piezoelectric vibrator is reduced. (See *Id.* at page 4, lines 2-12.)

In addition, in Appellants' ink-jet recording head, an insulator layer 13 is provided on the upper electrode 12 to prevent (1) deterioration by atmospheric moisture or the like, and (2) occurrence of surface discharge along the lateral sides (see *Id.* at page 12, lines 12-26; see also, for example, Appellants' Fig.2A). Conductor window(s) 13a is(are) formed in the insulator layer 13 such that the conductor pattern 14 is connected to the upper electrode 12 via the window(s) 13a. This design is effective in supplying a drive signal to the upper electrode 12 with the smallest possible response delay (see *Id.* at page 12, lines 1-11.)

ISSUES

1. Whether claims 1 and 7, and thereby their respective dependent claims 2-6 and 8-12, would have been obvious within the meaning of 35 U.S.C. §103 in view of Yamamuro et al. in view of Okabayashi et al.?

GROUPING OF CLAIMS

Claims 1 - 12 stand or fall together.

ARGUMENTS

1. Claim 1-12 would not have been obvious within the meaning of 35 U.S.C. §103 over the cited Art.

REMARKS

The Examiner rejects claims 1-12 as being unpatentable over Yamamuro et al. (Yamamuro) in view of Okabayashi et al. (Okabayashi). This rejection is believed to be in error.

Yamamuro is in the field of ink jet recording devices, and is directed to the composition of the piezoelectric material used in ink jet heads for compressing ink in an ink jet chamber to eject a drop of ink from a nozzle. In particular, Yamamuro teaches a structure for a "bimorph" ink jet head, i.e., an ink jet head wherein the piezoelectric layer is composed of two thin films of piezoelectric material. In particular, Yamamuro discloses a structure of a bimorph ink jet head and a procedure for assembling the same. (See Yamamuro at col. 11, line 27 to col. 13, line 61; see also Yamamuro Figs. 24A - 31.)

As explained in the March 29, 1999 Amendment, Yamamuro does not teach or suggest an upper insulator layer formed on the upper electrodes, as recited in independent claims 1 and 7. As shown in Fig. 25A of Yamamuro, protective layer 78 is formed on conductive layer 76, that in turn is formed on a first film of piezoelectric layer 70, such that layers 78, 76 and 70 (first film) constitute protective layer 80. Also, a second film of piezoelectric layer 70 and conductive layer 72 constitute layer 74. Layers 80 and 74 are stacked with respect to housing 16 (that includes nozzles, ink chambers, etc.) as shown in Fig. 25B of Yamamuro. In addition, Fig. 25B of Yamamuro shows electrodes 82 and leads (not shown) formed between layers 80 and 74. (See Yamamuro at col. 11, line 63 to col. 12, line 26.) Assuming *arguendo* that Yamamuro's protective layer 78, conductive layer 76 and piezoelectric layer 70 correspond to Appellants' "elastic sheet", "lower electrode" and "piezoelectric layer", respectively (as recited in claims 1 and 7), then Yamamuro's electrodes 82 and conductive layer 76 do not have an insulator layer formed on any portion thereof, as required in claims 1 and 7: "an insulator layer ... formed on a portion of the upper electrodes" (*Id.*).

Further, Yamamuro does not teach or suggest a conductor pattern which connects with the upper electrodes through windows formed in the insulator layer, as recited in independent claims 1 and 7. In fact, Yamamuro does not disclose or even suggest, that either of the conductive layers 76 and 72 connects to a conductor pattern, let alone teach or suggest that such a connection is made though a window. On the other hand, Yamamuro discloses that electrodes 82 are connected to leads (not shown), but does not disclose or even suggest how such connection is achieved.

Okabayashi discloses a method for connecting nozzle tube of ink jet nozzle with piezoelectric element utilizing a bonding agent. In particular, Okabayashi discloses a method whereby a cylindrically shaped piezoelectric element 6 (having a coating 11 applied to the entire surface thereof) is secured to nozzle tube 5 through the bonding agent 7 (see Okabayashi at col. 2, lines 46-68; see also Okabayashi Fig. 1).

As explained above and in the September 2, 1999 Response, Yamamuro and Okabayashi fail to teach or suggest:

> **an insulator layer having windows,** wherein the insulator layer is formed on a portion of the upper electrodes; and
>
> a conductor pattern connecting with the upper electrodes **through the windows of the insulator layer** (independent claims 1 and 7, emphasis added).

In fact, the Examiner acknowledges that Yamamuro does not disclose an insulator layer having a window and relies on Okabayashi to supply this deficiency (see final Office Action, Paper No. 14, dated June 10, 1999). In particular, referring to Okabayashi's Fig. 1, the Examiner alleges that Okabayashi discloses an insulator layer 11 having an insulating window 9c. Appellants respectfully submit that Okabayashi's element 9c is <u>not</u> a window in the insulating layer 11. In fact, Okabayashi discloses that:

> [s]hown at 9c in FIG. 3 is **an insulating gap** between the electrodes 9a and 9b" (col. 1, lines 39-40, emphasis added).

This insulating gap is necessary to separate electrodes 9a and 9b so that:

> [w]hen an electric voltage is applied between the electrodes 9a and 9b, the piezoelectric material 8 is contracted such that the nozzle

> tube 5 reduces its diameter whereby ink is injected from the jet nozzle (col. 1, lines 41-45).

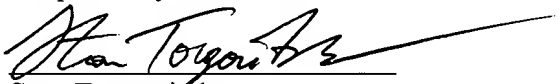
Therefore, Okabayashi does not disclose, or even suggest, an insulating layer having a window, but rather teaches an insulating layer 11 which extends into a gap 9c between the electrodes 9a and 9b. In other words, part of the insulating material which forms insulator layer 11 is disposed in the gap 9c.

Accordingly, independent claims 1 and 7, as well as their respective dependent claims 2-6 and 8-12, would not have been obvious from the prior art at least for the reasons noted above.

In view of the foregoing, Appellants submits that claims 1-12 are patentably distinct from the prior art. Therefore, the Board is respectfully requested to reverse the Examiner's position to the contrary, and to remand the application to the Examiner with an instruction to pass the case to allowance.

The present Brief on Appeal is being filed in triplicate. Appellants hereby petition for any extension of time which may be required to maintain the pendency of this case, and any required fee for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,



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APPENDIX

CLAIMS 1-12 ON APPEAL:

1. An ink jet recording head comprising:

an elastic sheet facing pressure generating chambers;

nozzle orifices communicating with the pressure generating chambers;

piezoelectric vibrators formed on the elastic sheet, each of the piezoelectric vibrators having,

a lower electrode formed on the elastic sheet,

a piezoelectric layer formed on the lower electrode, and

an upper electrode formed on the piezoelectric layer such that the upper electrode faces a respective pressure generating chamber, wherein the upper electrodes of the piezoelectric vibrators are positioned independently of each other;

an insulator layer having windows, wherein the insulator layer is formed on a portion of the upper electrodes; and

a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

2. The ink-jet recording head according to claim 1, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

3. The ink-jet recording head according to claim 1, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

4. The ink-jet recording head according to claim 1, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

5. The ink-jet recording head according to claim 4, wherein the insulator is made of polyimide.

6. The ink-jet recording head according to claim 1, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

7. An ink jet recording head comprising:

an elastic sheet facing pressure generating chambers;

nozzle orifices communicating with the pressure generating chambers;

piezoelectric vibrators formed on the elastic sheet, each of the piezoelectric vibrators having,

a lower electrode formed on the elastic sheet,

a piezoelectric layer formed on the lower electrode, and

an upper electrode formed on the piezoelectric layer such that the upper electrode faces the respective pressure generating chamber, wherein the piezoelectric layer and the upper electrode are formed entirely inside of areas facing the respective pressure generating chamber;

an insulator layer having windows, wherein insulator layer is formed on a portion of the upper electrodes; and

a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

8. The ink-jet recording head according to claim 7, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

9. The ink-jet recording head according to claim 7, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

10. The ink-jet recording head according to claim 7, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

11. The ink-jet recording head according to claim 10, wherein the insulator is made of polyimide.

12. The ink-jet recording head according to claim 7, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.